

## **TRAFFIC SAFETY AND DISASTER MANAGEMENT FACILITIES IN INCHEON BRIDGE PROJECT**

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**Abstract:** *Incheon Bridge fulfils an important function as an access road to Incheon International Airport. However, being a bridge section, it is also vulnerable to disasters. To worsen the situation, the area of Incheon is a misty area characterized by loss of visibility. Incheon Bridge necessitates thus the establishment of infrastructures enabling to manage traffic delays and tie-up caused by disasters. Accordingly, traffic safety and disaster management facilities were installed in Incheon Bridge.*

**Keywords:** pile-bent, seismic design, nonlinear analysis, seismic performance

## **1. SURROUNDING ENVIRONMENT**

The frequency of fog occurrence in the area of Incheon reaches 62 days per year with an average duration of 252 hours (Fig. 1), which are significantly higher than the averages for the whole country (30 to 50 days per year and duration of 150 hours).

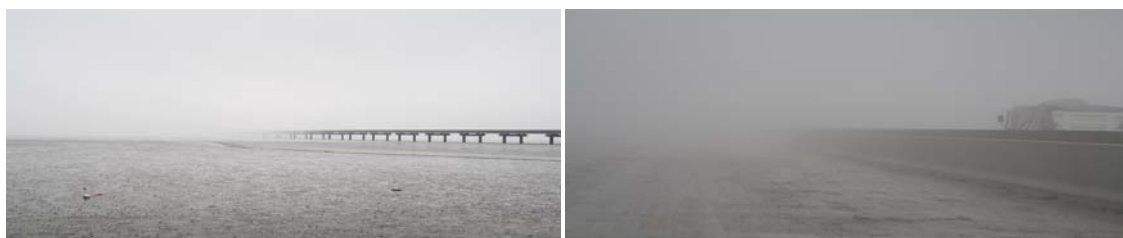


Figure 1: Fog at Incheon Bridge



Figure 2: Examples of traffic tie-up due to accident, snow, and fire

The bridge section is vulnerable to fire and frost and offers poor possibilities for the detour of traffic and access of emergency vehicles (Fig. 2).

Moreover, traffic congestion or delay in Incheon Bridge is likely to provoke serious damages to the users. This route is significantly more sensitive to the time and cost losses of the users than other routes. Therefore, Incheon Bridge will play an important role in the national and international image of our country. Accordingly, considering the future role of the bridge as infrastructure for international exchange and communication, the establishment of facilities enabling prompt response to all types of disaster, calamities and traffic congestion is of extreme importance.

## 2. SUMMARY OF THE ESTABLISHMENT OF DISASTER MANAGEMENT SYSTEM

The main objects of the establishment of the disaster management system are (1) the beforehand removal and minimization of the causes of disaster; (2) the promotion of the prompt, precise and efficient evaluation, communication and countermeasures during the occurrence of the disaster; and, (3) the realization of a standard model of disaster prevention system for the long-span bridge with an international scale.

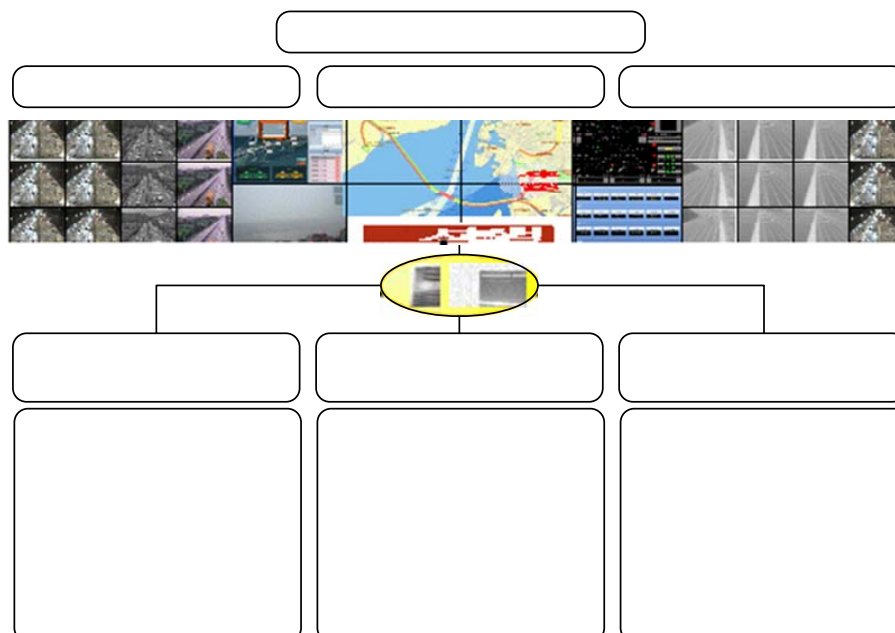


Figure 3: Organization of the traffic management center in Incheon Bridge

## 3. INSTALLATION PLANNING OF DISASTER MANAGEMENT FACILITIES

Action	Facilities	Design item		Objectives
		Private section	Government section	
Acquisition of information	Road weather information system (RWIS)	4	1	Acquisition of weather information
	Closed-circuit television (CCTV)	17	6	Estimation of traffic
	Vehicle detector (video)	26	16	Acquisition of traffic information
	Vehicle detector (radar)	7	5	Acquisition of traffic information (preparation to fog)
	Emergency phone	8	–	User's alarm
Transmission of information	Roadside information system (VMS)	13	12	Roadside information signboard
	Lane control system (LCS)	12	4	Provision of lane traffic information
	Emergency broadcast	68	–	Outdoor broadcast to users
	Emergency alarm light	5	–	Switch under emergency and alarm
	Wind cone	5	3	Provision of wind information
Fire fighting	Extinguisher	268	26	Early measure against fire
Emergency road	Turning road	4	2	Emergency detour of vehicles
Early automatic defrosting facilities	Salt water spraying facilities	3 (1,320m)	7 (1,594m)	Preparation to early snowfall (prevention of roadway freezing)
Durability maintenance of safety facilities	Surface strengthening agent (anti-salt ingress paint)	Whole section (bottom of protection wall)	Whole section (bottom of protection wall)	Extension of lifespan of safety fence, prevention of degradation due to snowing removal works
Safety facilities	Visual guidance light	480	243	
	Fog sign	–	8	Visibility, warning, enlightenment
	Protruded lane painting	Whole section	Whole section	



## 4. STATUS OF DISASTER MANAGEMENT FACILITIES

### 4.1 Radar Vehicle Detector

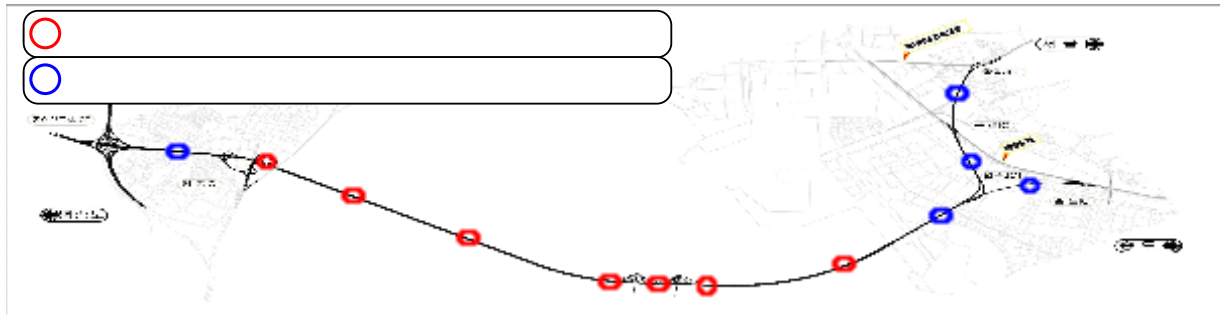
#### 4.1.1 Objectives of installation

The radar vehicle detector aims to prevent safety accidents and promote safe riding of the users through continuous and efficient acquisition of traffic information and transmission of information during weather deterioration like fog.

#### 4.1.2 Installation planning

	Radar vehicle detector	Alarm · warning facilities
Summary		
Characteristics	Not affected by night, sunset and, sunrise. Securing of vehicle detection performance even under bad weather like fog, rainfall and snowfall	Prevention of secondary accidents through visual and auditive warning signs to the users during emergency Remotely controllable according to traffic conditions

#### 4.1.3 Position of installation



#### 4.1.4 Expected effects

The expected effects of the installation of the radar vehicle detection and warning facilities are (1) the ease of acquisition of information and estimation of traffic even under bad weather like fog, (2) the possibility of early and prompt measures such as the transmission of information to the users, and (3) the prevention of chain collisions during fog like the experience of Seohae Bridge.

### 4.2 Saline Water Spraying Devices

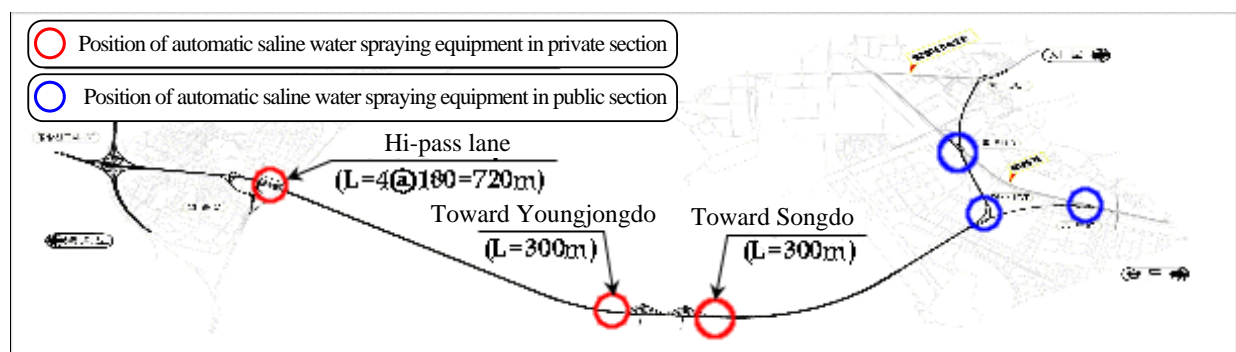
#### 4.2.1 Objectives of installation

The saline water spraying device aims to provide prompt and early snow removal in sections vulnerable to snow damage where problems caused by surface freezing are expected (sections with steep longitudinal and transverse slopes) when early snow removal is delayed during snowfall in winter.





#### 4.2.2 Installation sections

The device is installed at spots among downward slopes (longitudinal slope  $> 3\%$ ) where the longitudinal alignment changes from a straight line to a curve presenting high risk of traffic accident caused by sliding during braking, and positions with high risk of accidents due to surface freezing among hi-pass sections and, IC and JCT ramps where the early access of snow removal vehicles is difficult during snowfall.

#### 4.2.3 Position of installation



#### 4.2.4 Management planning by stage

			
(1) Identification of the status of snow removal section	(2) Remote control of spraying	(3) Operation of control box	(4) Automatic spraying at vulnerable sections

#### 4.2.5 Expected effects

The saline water spraying system will enable efficient disaster management in vulnerable sections by early measures against surface freezing. In particular, this system will improve the vulnerability of the bridge for which the accessibility and emergency measures are difficult. The system will thus provide full preparedness to all kind of disaster events.

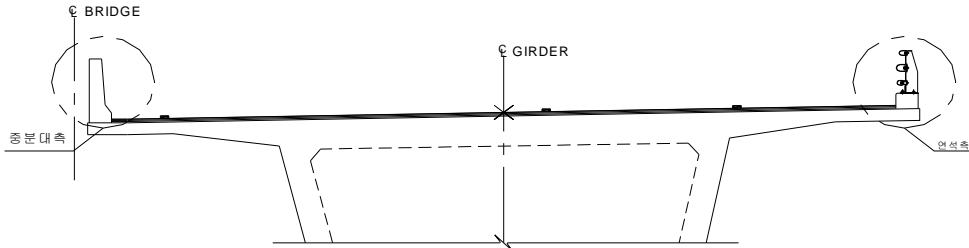
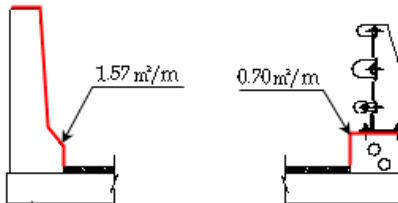
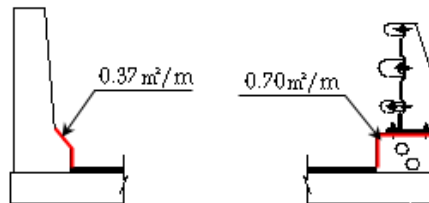
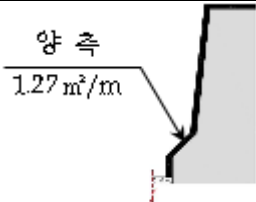
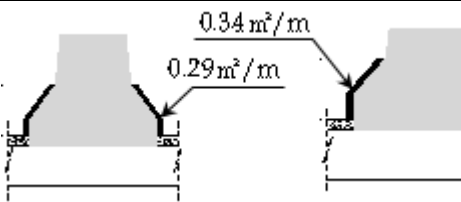
### 4.3 Anti-Salt Ingress Coating

#### 4.3.1 Objectives of installation

This coating aims to prevent salt ingress of the bridge structure through surface strengthening action preventing early degradation of concrete in the median separation and curbs due to chlorides brought by the saline water spraying devices and snow removal works.

#### 4.1.2 Installation planning

The coating is installed on the whole width of the sections equipped with saline water spraying devices including the portions extending up to 30m before and after these sections as well as in ordinary section (partial execution). The silicone penetration concrete protection material already used in numerous bridges like Stonecutters Bridge (Hong Kong) is applied on the top and sides (right and left) of the concrete fence protection walls or median separation.

			
	Sections with saline water spraying devices	Ordinary sections	
Private			
Government			
		<Median separation>	<Fence>

#### 4.3.3 Expected effects

The application of anti-salt-ingress coating will improve the durability of the concrete median separation and curb structures against the ingress of the chlorides introduced by snow removal and crossing vehicles. This will also contribute to the stability of the vehicle protection facilities.

#### 4.4 Emergency Detour Facilities

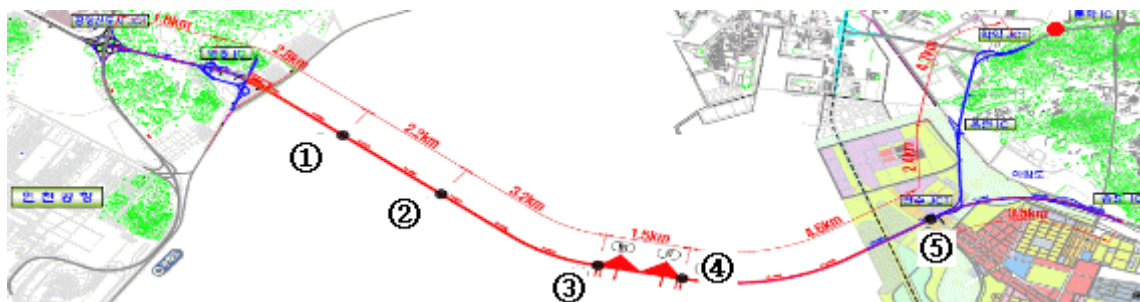
##### 4.4.1 Objectives of installation

The emergency detour facilities are sufficiently installed to secure emergency evacuation of the vehicles to the opposite lane under excessive traffic congestion due to the occurrence of any type of troubles in the framework of the maintenance and management of Incheon Bridge.

##### 4.4.2 Installation criteria

According to the specifications of the Korea Expressway Corporation, detour facilities shall be installed every 5km for traffic detour (extension of 121m for 6 lanes) and every 2.5km for emergency detour (extension of 17m). To date, there is no example of installation of external openings in bridge structures in Korea.

##### 4.4.3 Position of installation



Location (STA)	Initial (3 spots)	Modified (5 spots)	Remarks
(1) Western viaduct (4+635)	—	Rail type	Extended length per position (17m)
(2) Western viaduct (6+785)	—	Rail type	
(3) Start of cable-stayed bridge (9+924)	Bolt type	Rail type	
(4) End of cable-stayed bridge (11+404)	Bolt type	Rail type	
(5) Lot 2 (1+287~1+304)	Rail type	Rail type	

The initial alternative has been modified into the rail type for prompt opening and shutting.

##### 4.4.4 Installation cross-section

According to the specifications of the Korea Expressway Corporation, detour facilities shall be installed

	Place of installation		Remarks
Details	Western viaduct (4+635, 6+785)	Start and end of cable-stayed bridge (9+924, 11+404)	
Cross-section			
Composition	Two-level guardrail type	Two-level guardrail type	



	Installation of bed plate at the gap on the bridge superstructure	Installation of bed plate for the connection of post and stiffening girder	
Protection performance	SB-5 class (applied for high speed sections (design speed > 100km/hr))		

#### 4.4.5 Expected effects



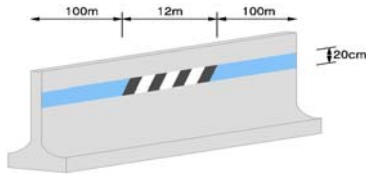
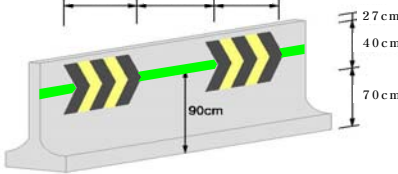
The installation of emergency detour facilities will minimize damages to the users by preventing all types of disasters and enabling emergency evacuation of the users in case of any event occurring on the road. In addition, these facilities will contribute to the improvement of the efficiency of the disaster management of Incheon Bridge.

### 4.5 Visual Guidance Painting at Median Stripe

#### 4.5.1 Objectives of installation

Visual guidance painting aims to alleviate the monotony and coerciveness given by the concrete median stripe (H = 1.27m).

#### 4.5.2 Installation planning

Items	Ordinary section	Approaches of cable-stayed bridge	Remarks
Picture			
Criteria	One line (blue) + Gridiron pattern (black + white)	One line (green) + Chevron (black + yellow)	
Dimensions			
Position	Ordinary section	Curves at the access ends of the cable-stayed bridge and sections with steep slope	

#### 4.5.3 Expected effects

The installation of visual guidance paint on the median separation reduces the monotony and coercive feeling given by the concrete blocks and, improves the road environment. Moreover, this visual guidance is contributing to the recognition and acknowledgement of the users (prevention of momentary confusion due to the same concrete colour of the protection wall and road surface).



### 4.6 Wind Cone

#### 4.6.1 Objectives of installation

Since Incheon Bridge is featured by frequent occurrence of strong winds, wind cones are installed to provide visual information on the intensity of wind to the drivers and, to contribute to their self-awareness for safe driving.

4.6.2 Installation planning

Five wind cones are installed at intervals of 2~3km in the private section and, 3 cones are installed in the public section.

Photograph of installed cone	Position of the cones
	

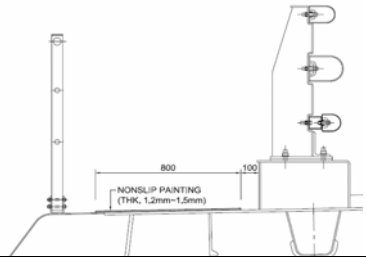
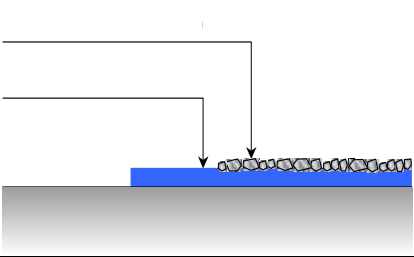

4.7 Anti-Slip Painting of the Inspection Path of the Cable-Stayed Bridge

4.7.1 Objectives of installation

Travelling and access of unspecified staff for inspection and maintenance purposes are previewed in the future. Therefore, anti-slip painting has been applied on the floor to prevent safety accidents like falling due to slipping floor.

4.7.2 Installation planning

The anti-slip coating has been applied on an area of 2,314m<sup>2</sup> (except 54m<sup>2</sup> of the cable anchorage) at both sides of the cable-stayed bridge in the private section (L = 1,480m), and an area of 930m<sup>2</sup> at both sides of the cable-stayed bridge in the public section (L = 230m).

Detailed drawing	Construction plan	Example of construction (Youngjong Bridge)
		


4.8 Platform for Sand

4.8.1 Objectives of installation

Owing to the characteristics of the bridge, traffic congestion is likely to occur in case of snowfall due to the difficulty for snow removing equipment to access on the bridge. Therefore, platforms have been installed to provide in permanence snow removing agent for prompt countermeasures.

4.8.2 Installation planning



Items	Installation project	Position
Photograph of installation		<p>※ Installation in 140 spots in the 3.5km long curved section with steep slope at the approach extremities of the cable-stayed bridge</p> <p>※ Installation in 105 spots in the ramps for which high risk of freezing is forecasted due to their disadvantageous geometry compared to the main line</p>
Features	Satisfactory aesthetic appearance through the application of vertically movable platforms	

#### 4.8.3 Expected effects

The installation of these platforms enables to secure storage of snow removing agents and be permanently prepared for the occurrence of emergencies. In addition, such facilities will contribute to the execution of prompt countermeasures in case of snowfall and freezing of the road surface.